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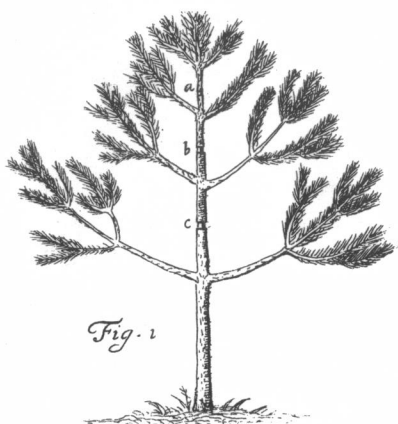


Fig. 1

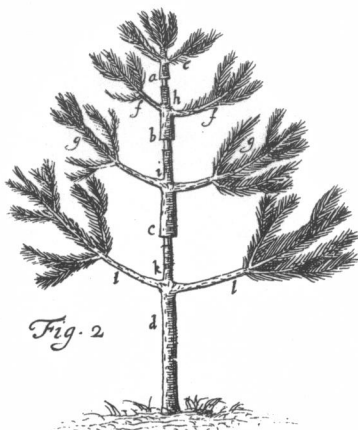


Fig. 2

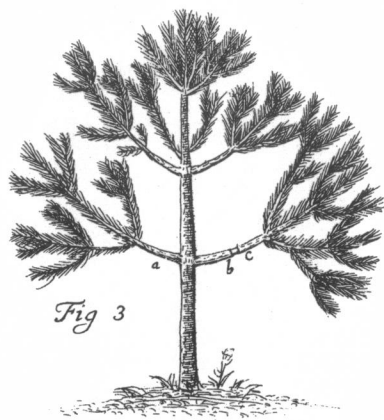


Fig. 3

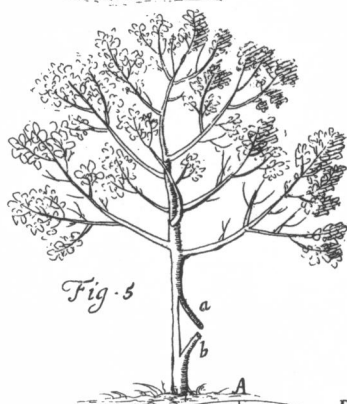


Fig. 5

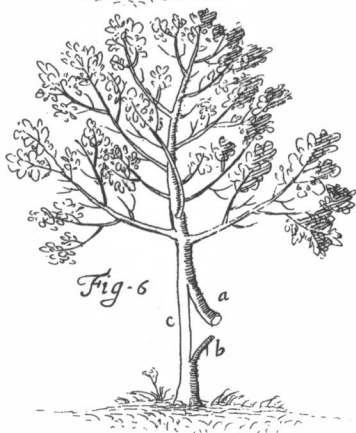


Fig. 6

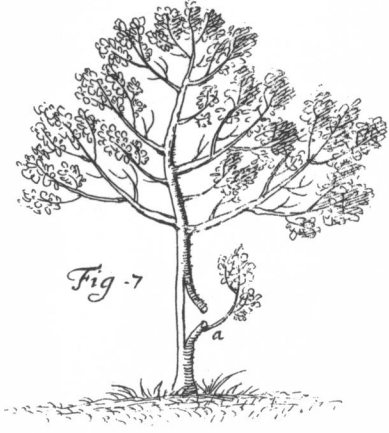


Fig. 7

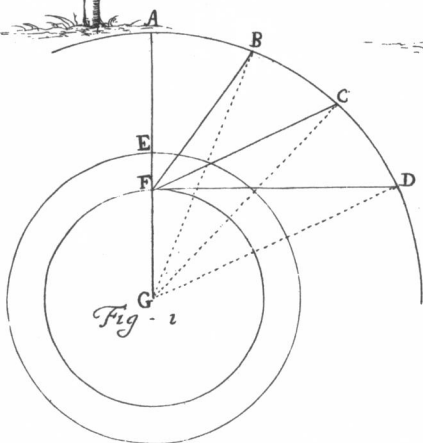
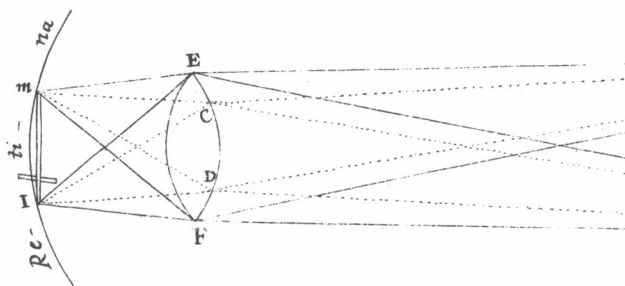


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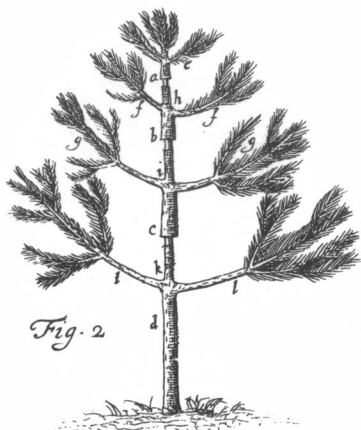


Fig. 2

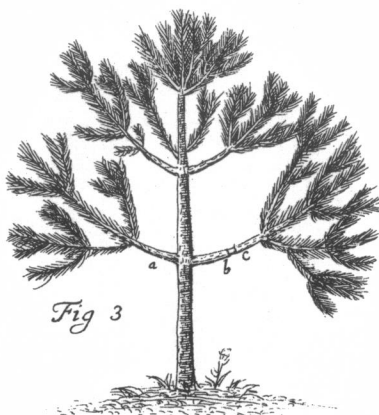


Fig. 3

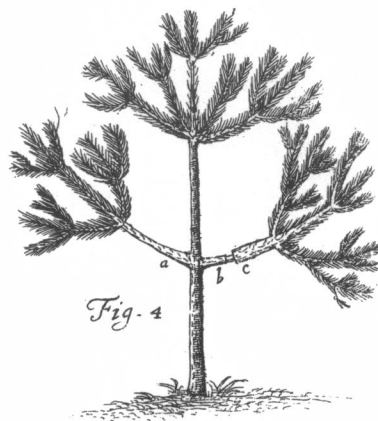


Fig. 4

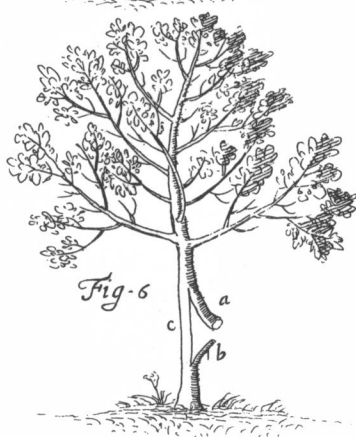


Fig. 6

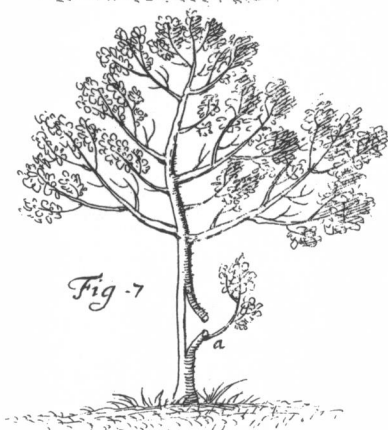


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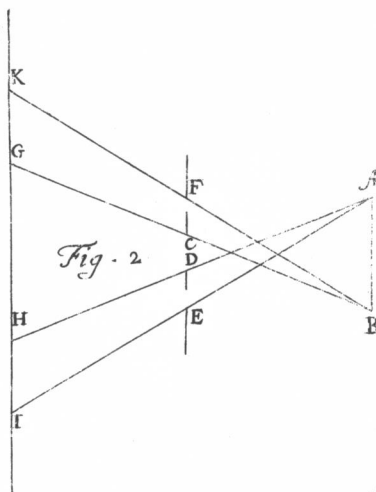


Fig. 2

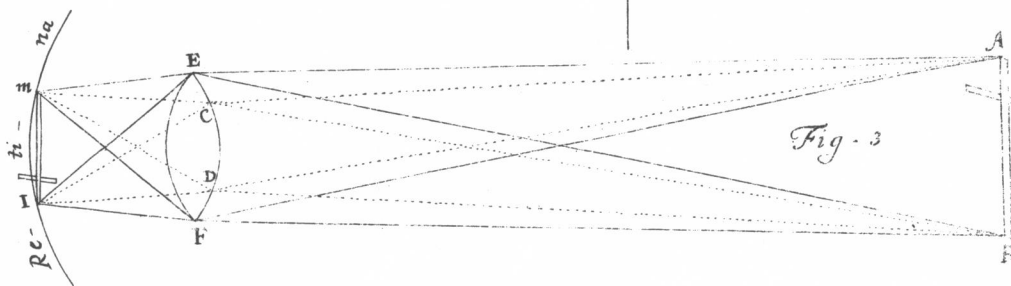
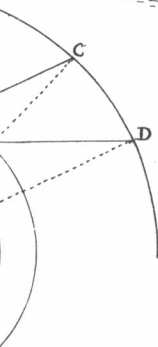


Fig. 3

An Account of several curious Observations and Experiments, concerning the Growth of Trees; made by Thomas Brotherton, of Hey, in the County of Lancaster, Esq; Brought in and Read before the R. S. by R. H. Fellow of the said Society.

The Experiments and Observations, were made at Hey, in the County of Lancaster.

THE first Experiment was made in the Year 1671, upon a Crab-Tree, about four Inches in Diameter; it was hacked round with a Hatchet, so as to cut pretty deep into the Wood, besides the cutting off of the Bark, for about four Inches wide. After which, it was the same Year observed to increase above the said hacking very considerably; and to shoot in length of Wood, about one Foot; the next Year it increased considerably, and shot in length about nine Inches: But the third Year it dyed to the very Root.

Much the like was observed in another, part of whose Bark was eaten off by a Canker, that the lower Part stood, without increasing, and by degrees the Wood rotted and mortified; but the upper part increased to the 3d Year, when it dyed also.

Most of the following Experiments were tryed on the *Abies* or *Scotch-Firr*, and on the black *Poplar* with white Bark, and on *Hazel* and *Ash* Trees.

A *Scotch-Firr* of three Years growth, having a Ring of the Bark cut off, of the Breadth of three Inches, near the bottom of the Stem or Stalk, below the uppermost Knot or Joynt, was observed to grow and shoot out its Top, about

half a Yard; and the Parts all about the Ring, to increase very much in thickness the same Year the Section was made, and to increase in thickness, much more than it would have done if the Section had not been made: But all that part of the Stock, between the said Ring and the Knot next below it, increased not at all; but that part which was below the next Knot increased somewhat, yet not so much as if the said Ring of the Bark had not been cut off. The 2^d Year it also increased considerably, but not so much as the first; but the third Year it died. The Branch that was here produced, had the Ring cut off from it, *April* the 1st, 1686, and the part above the Section increased, and grew till the 17th of *October* following, when it was cut off from the Tree. In this space of time the part below the Ring increased not at all, but stood at a stay; but the part about the Ring shot out a new Joynt, between a Foot and half a Yard, and increased in thickness for the whole length of it, and in all its parts twice as much as it would have done, if it had not been cut, as was apparent by a like Branch on the opposite side of the Knot, which was not cut or barked round in the same manner: The Bark also of the part above the Section, swelled, or grew downwards over the woody part, (which was bare) above half an Inch in breadth.

The usual time for making this Section, was either in *March* or the Beginning of *April*.

Tryal was made upon some young Trees cutting a helical swath of the Bark, about half an Inch in breadth, by leaving a like helical swath of Bark to communicate between the upper and under part; in this Tryal, the difference of growth succeeded not, but the remaining swath of the Bark swelled downwards, and by the end of the Year, covered the bared part of the Wood.

The like event almost followed, upon making an indented Section round, of about half an Inch in breadth; the
upper

upper Bark quickly swelling downward, and joyning again with the lower.

It was also observable, that as the upper Bark grew downwards; so it increased also in thickness, whereas the Bark below the Section thickned not at all.

Several of those Boughs, which were about one Inch in Diameter, and had increased, as above, the Summer before, were observed to out-live the great Frost, and to receive no considerable Damage; whereas many others otherwise ordered, were killed by it, as will appear by and by, more particularly.

In the first *Fig.* is represented a *Scotch Firr* of three Years growth, (it shooting forth every Year, both from the Body, and the Branches a new Joynt and circumambient Sprouts, to a determinate length) barked with three Rings, of about $1\frac{1}{2}$ Inch broad, each about the middle of the Internodia or parts of the Stock between the Joynts, at *c b*, & *a*; this in one Year increased and shot forth branchings, as in the second *Fig.* that is the Stock at *a*, which was about the bigness of a Quill, below the Ring to the next Joynt continued of the same bigness, but above the Ring it increased and grew to the bigness of ones Finger, and from the new Joynt at *e* shot out new Limbs and Stock about a quarter of a Yard, which was somewhat bigger, than if there had been no Ring made. Next the Branches *ff* increased likewise proportionably, by swelling in bigness, and from a new Joynt shooting out new Body and Limbs, as the Top or Body; and the Body of the Tree below the Joynt *b* to the Ring *b*, increased more than if the Ring had not been made; but the part of the Stock below the Ring to the next Joynt, increased not at all. The like shooting forth and increasing, was observed in the 2^d Limb's Joynt and Stock below it *g g. i* to *c*, between which and *k*, it increased not.

The like also succeeded in the lower Branches *l l*, and Joynt *k*, and in the Stock *d*, below the Joynt *k*.

Fig. the 3d, Represents a young *Scotch-Fir* of two Years old, on one of the lowermost Branches *c*, was made a Ring-Section between the Body and first Knot of the Limb. The following Year, that part of the Limb above the Ring increased twice or thrice as much as the corresponding parts of the other Limbs, from the same Knot, as *a*, which increased as if there had been no Section made at *B*, but the part below *b* to the Body, increased not at all.

Fig. 5. represents a young *Hazel* cut into the Body with a deep gash, and the parts of the Body above and below cleft upwards and downwards, and the Splinters *a* and *b*, by Wedges kept off from touching each other, or the rest of the Body. These the following Year were observed to be in the State represented in the *6th Fig.* that is, the Splinter *a* above the Gash, was grown very much, but the Splinter *b* below, stood at a Stay and grew not, but the rest of the Body at *c*, grew as if there had been no Gash made.

Fig. 7. Represents a like Gash made just above the lowermost Knot; and the parts splinter'd or cleft and wedged off from each other, and from the Body as before, but there is left a Branch upon the lower Splinter to see what will be the State thereof the next Year, or in *October* next. When 'tis probable by the other Experiments the lower Splinter and Branch upon it, will be found to have grown and increased as the Splinter in the former Experiment did above the Gash, though not in the same Proportion.

Fig. 8. Represents four young *Poplar* Trees, *A, B, C, D*, all of equal bigness, growth, situation, and soil, as near as could be found; these were ordered as is represented in the *9th Fig.* that is, *A* had all its Branches and Top cut off, *B* had all its Branches pruned off, but it was left with a small Head at the Top. *C* had the Branches cut about half way, and those of the upper half left growing. *D* was left grow-

growing without being at all pruned or lopped ; the event was expected.

The success was found to be thus, *A* in the following Years shot out many Twigs round about, but the Body increased but little in height or bigness. *B* shot out likewise many Twigs where it had been pruned, and the top-branches and top also increased considerably, and the Body also increased much more in height and bigness than did the former *A*. *C* increased yet much more in all its parts than *B*. But *D* increased in Limbs, Height, and Bigness most of all ; swelling in Bigness, and stretching in Height, and spreading in its Boughs much more than *C*; and in about 10 Years, was more than four times as big as *A*.

The same worthy Person also observed, that all the *Poplars* that had been pruned, dyed in the great Frost 1684, in so much, that of 25 that were so ordered, he observed 19 of them to be killed by it, and the remaining to be very weak and hardly able to recover, and increased very little in the following Years. These *Poplars* were about 30 Foot high, and had only a small Head left at the Top unlopped, of about 4 or 5 Foot, and were pruned, the Spring before the great Frost. He observed also, that divers of those which had been pruned two Summers before the Frost, were killed by it: But none of those which had not been pruned at all, were hurt by it. He took Notice also, both in *Lancashire* and *Cheshire*, that Trees of 60 Foot in height, that had been pruned, and had only a small Top left, were also killed by the said Frost; whereas those Trees of the same Kind and Height, which stood near to them, but had not been pruned, continued to flourish, and suffered no Harm thereby. Several of those Branches of about an Inch Diameter, and Trees that had been barked round, as above, the Spring before the great Frost, out-lived the Violence of the same, and the preceding Winter.

Where

Where these prunings had been tried upon Trees 20 Foot high, the difference of their Increase, was sensible the following Summer, but in 7 or 8 Years time, the difference is prodigious; the unpruned Trees growing several times bigger than the pruned, both in Body and Branches, even to Admiration.

He hath often observed, also that when the Top Branches would shoot out and grow 2 Foot, or more, in length; the lower Branches would not shoot above 4 Inches. And further, that in the Branches of the *Scotch Fir*, the Joynts above the Rings barked round, would increase and grow much bigger in 3 Years, than they would in 5 Years, if the said Rings were not cut off.

The same Person, upon Discourfing some other particular Inquiries about the Spreading and Increase of the Roots, assured me, that he had observed a very large *Pinafter* about two Foot and an half in Diameter, and of a height proportionable, (*viz.* of about 20 Yards; the lowest Boughs of which, were about 30 Foot above the Ground) did spread and flourish on every side alike, tho' it had no Root at all towards three quarters of its Situation, but only towards one quarter, into which it spread its Roots very far and large, divers of them reaching about 70 or 80 Foot from the Body of the Tree: The Reason of which spreading was occasioned by its being planted just within the square Angle of the Corner of a deep, thick and strong Stone-Wall, which was a kind of Bauking or Wharfing against a River that ran by it: This Tree, I say, tho' it had nourishment only from one quarter of four to its Roots, yet did the same flourish and spread equally on every side.

Upon Consideration of these and divers other Observations, and Experiments, Mr. *Brotherton* is of Opinion,
1. That the Sap (most of it, if not all) ascends in the Vessels of the lignous part of the Tree, and not in the Cortical Part, nor between the Cortical and Lignous Parts.

2. That

2. That the Increase and Growth of a Tree in thickness is by the descent of the Sap, and not by the ascent; and if there were no descent, a Tree would increase but very little, if at all.

3. That there is a continual Circulation of the Sap all the Summer Season, and during such time as the Sap is stirring, and not a Descent at *Michaelmas* only, as some have held.

To me it seems very probable, that the Bodies of Plants, as well as those of moving Animals, are nourished and increased by a double Food; the one an impregnated Water, and the other an impregnated Air, and that without a convenient supply of these two, the Vegetable cannot subsist, at least not increase. These do mutually mix and coalesce, and parts of the Air convert to Water, and parts of Water convert to Air. As some of this latter are rarified and freed from their Chains and become Spiritual and Aëry, so others of the fore-mentioned, are clogged, and fettered, and become debased. To this purpose all Plants as well as Animals, have a twofold kind of Roots, one that branches and spreads into the Earth, and another that spreads and shoots into the Air, both Kinds of Roots serve to receive and carry their proper Nourishment to the Body of the Plant, and both serve also to convey and carry off the useless Recrements; useless I mean any further within the Body of the Plant, though useful to it when they are separated, and without it, the one for Seasoning the Earth and Water wherein it is planted, and the other for seasoning and preparing the Air, the Method of which I have elsewhere explained.